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SOME CHARACTERISTICS OF WEEKEND TRAVEL TO INDIANA STATE PARKS

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by

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PURDUE UNIVERSITY
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Technical Paper

SOME CHARACTERISTICS OF WEEKEND TRAVEL TO INDIANA STATE PARKS

TO: K. B. Woods, Director
Joint Highway Research Project

June 19, 1964

FROM: H. L. Michael, Associate Director
Joint Highway Research Project

Project: C-36-54CC
File: 3-3-29

The attached technical paper "Some Characteristics of Weekend Travel to Indiana State Parks" was presented at the 50th Annual Purdue Road School in March 1964. The authors, Lawrence L. Schulman and Professor William L. Grecco of our staff, summarized some of the material contained in a report titled "Traffic Generation and Distribution of Weekend Recreational Trips", the Final Report on Project C-36-54CC.

A regression model for the prediction of weekend trips to an Indiana State Park was developed and is included in the paper. The model contains ten variables found to be most important in the prediction model. The variable are measures of the size, facilities and activities in the park and the population adjacent to the park.

The results of this research provide considerable information on the traffic generation potential of an existing or proposed recreational area. Such information is vital in the planning of related transportation facilities in the area of the recreational site.

The paper is submitted for approval for publication in the Proceedings of the 50th Annual Road School.

Respectfully submitted,

Harold L. Michael

Harold L. Michael, Secretary

HLM:bc

Attachment

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Project: C-36-54CC

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Purdue University
Lafayette, Indiana

June 19, 1964

SOME CHARACTERISTICS OF WEEKEND TRAVEL TO INDIANA STATE PARKS

Lawrence L. Schulman
William L. Grecco

It is befitting that this study be presented here today since the idea originated from several papers on recreational travel and its importance which were presented at the last Road School. This study was concerned with the determination of a single exponent gravity model for the prediction of weekend recreational trips. However, before any work could be done with a model of this type the expression had to be clearly and precisely defined for the specific type of trip. It was, therefore, the ultimate purpose of the study to define for a recreational trip, the areas of origin and destination, the variables to represent the parameters of the model and then to determine the required constants. Having determined the model, a statistical analysis was made on the comparison of observed and calculated trips to check the ability of the model to predict weekend recreational travel.

The gravity model as used in this work is stated in its simplest form. It returns to the basic statement of the Newtonian gravitational concept and may be written as shown:

$$T_{ij} = K \frac{T_i \cdot T_j}{(D_{ij})^x}$$

where:

T_{ij} = the number of automobile trips from residential area j to recreational area i

T_i = the total number of automobile trips attracted to recreational area i

T_j = a measure of the relative ability of residential area j to generate automobile recreational trips

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D_{ij} = the road distance between residential area j and recreational area i

x = an exponent which is determined for the type of recreational trip of concern

K = a computational constant

Usage of the model in the above form shows that the model tends to either over or underestimate the total number of trips attracted to the park and must be corrected by multiplication of the number of trips attracted from each county by a correction factor

$$C.F. = \frac{K_i}{\sum_{j=1}^{n} T_{ij}}$$

where:

$\sum_{j=1}^{n} T_{ij}$ = the total number of trips attracted to recreational area i from all of the individual residential areas j

n = number of residential areas j

However, the need for using this correction factor can be eliminated and the computations simplified if the model is redefined. The resulting form is as shown:

$$T_{ij} = K_i \frac{\frac{R_j}{(D_{ij})^x}}{\sum_{j=1}^{n} \frac{R_j}{(D_{ij})^x}}$$

where

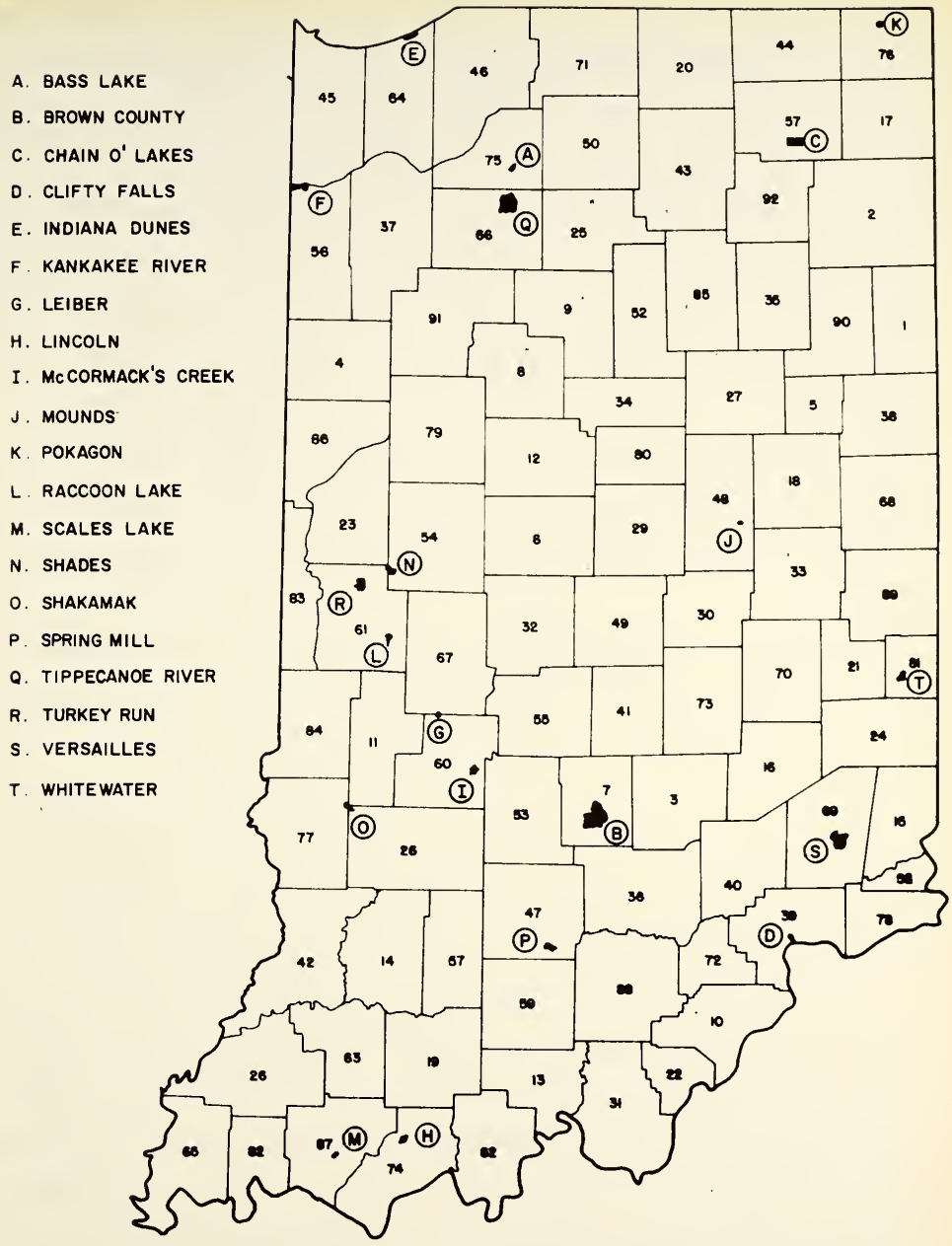
R_j = some measure of the ability of county j to generate recreational trips

By definition a trip of any specified length must represent a spatial movement between two areas - one serving as the origin and the other as the destination of the trip. Therefore, the initial decision in this study was to choose an area of origin and an area of destination for the

recreational trip. There are many different types of recreational trips made every week, each with varying destinations; however, in general, the recreational trip will begin at the home. For ease of data collection, the origin of the recreational trips was defined as the county.

Since there had been little previous work done in this area the choice of destination for the recreational trip was unrestricted. The choice of state parks was based on the availability and ease of data collection and the importance of this type of recreational trip in the immediate and long-range future. It is also felt that the model defined for this type of trip will be applicable to trips terminating at a recreational area constructed in conjunction with water resource projects. This area provides one of the greatest potentials for recreational development. At present there are twenty state parks in the system which are located as shown in Figure 1.

In this study a field survey was made on five of the twenty parks. These were Brown County, Mounds, Shades, Tippecanoe River and Turkey Run. The information required was the total number of trips from each county represented at the park. It was, therefore, necessary to determine the origin of each trip being made to the park during the study period. Since only the "county" of origin was desired, it was decided that a license plate study would be best, and because the Indiana license plates are prefixed by the county number, the data collection was made with little disturbance to the flow of traffic. Observations were made at each gatehouse while the admission fees were being collected. The trips were recorded by county of origin and also



LOCATION OF INDIANA STATE PARKS AND RECREATIONAL AREAS

Figure 1

by hour of arrival.

The data were collected for five consecutive weekends starting Friday, July 12, 1963 and ending Sunday, August 11, 1963. This time of the year was chosen since it was assumed that in general, peak weekend recreation travel would occur during the summer months. The observations were not continuous, but were made between the hours of 4:00-9:00 p.m. on Fridays, 8:00 a.m. - 8:00 p.m. on Saturdays and 8:00 a.m. - 6:00 p.m. on Sundays. These hours are assumed to include most of the weekend travel.

The individual trips from county to park were tallied by weekend. These figures represented the total number of recreational trips for each county to each of the five parks for each of the five weekends observed or variable T_{ij}.

The summation of all the T_{ij}'s for a specific weekend and specific park results in the total trips to that park for a weekend or variable T_i. This approximation is reasonable since most of the trips will arrive during the selected time periods.

The next quantity to be determined was some estimate of the number of recreational trips which could be generated by a county. To date, no satisfactory research had been done in this area, but some study had been done in the area of the social-recreational trips. It was decided to use the number of dwelling units in the county as a measure of recreational travel, where it has been shown that on the average there is approximately one social-recreational trip per dwelling unit per day.

The last quantity to be determined was D_{ij}, which is the road-distance between the county and the park. It has been a recent practice to replace distance with travel time; however, in this study replacement

was not deemed necessary. In most cases where this transformation has been made, the trips were internal or interzonal trips withing an urban area; however, most recreational trips, especially those to a state park, are external trips. In contrast to an internal trip, the study of external trips concerns travel on rural roads which for the most part will allow a "free flowing" movement. Therefore, the nature of the rural trip is such that on the average, the total travel time for all trips of a given length will be the same, and therefore, the use of total travel time would provide no additional accuracy in the study.

Having previously defined the origin as the county, it was assumed that the center of population for this area would be the county seat. Observations show that generally the county seat actually is located in the geographic center of the county. The road distances were established by a series of links connecting each county seat. The total distance between each county j and the park i was the summation of those links which resulted in the shortest trip. Figure 2 shows the series distance links determined for Indiana. Similar grids were developed for Michigan, Wisconsin, Illinois, Missouri, Tennessee, Kentucky and Ohio.

The model constants were computed from the collected data. In order to compute these values a Fortran IV Program was written for the IBM 7090. In essence, the program simulated the following mathematical procedures. The basic gravity model as previously stated can be rewritten in the form

$$K \cdot D_{ij}^{x} = \frac{T_i \quad T_j}{T_{ij}} = C_{ij}$$

where d_{ij} is an observable variable, C_{ij} is a calculated variable and K and

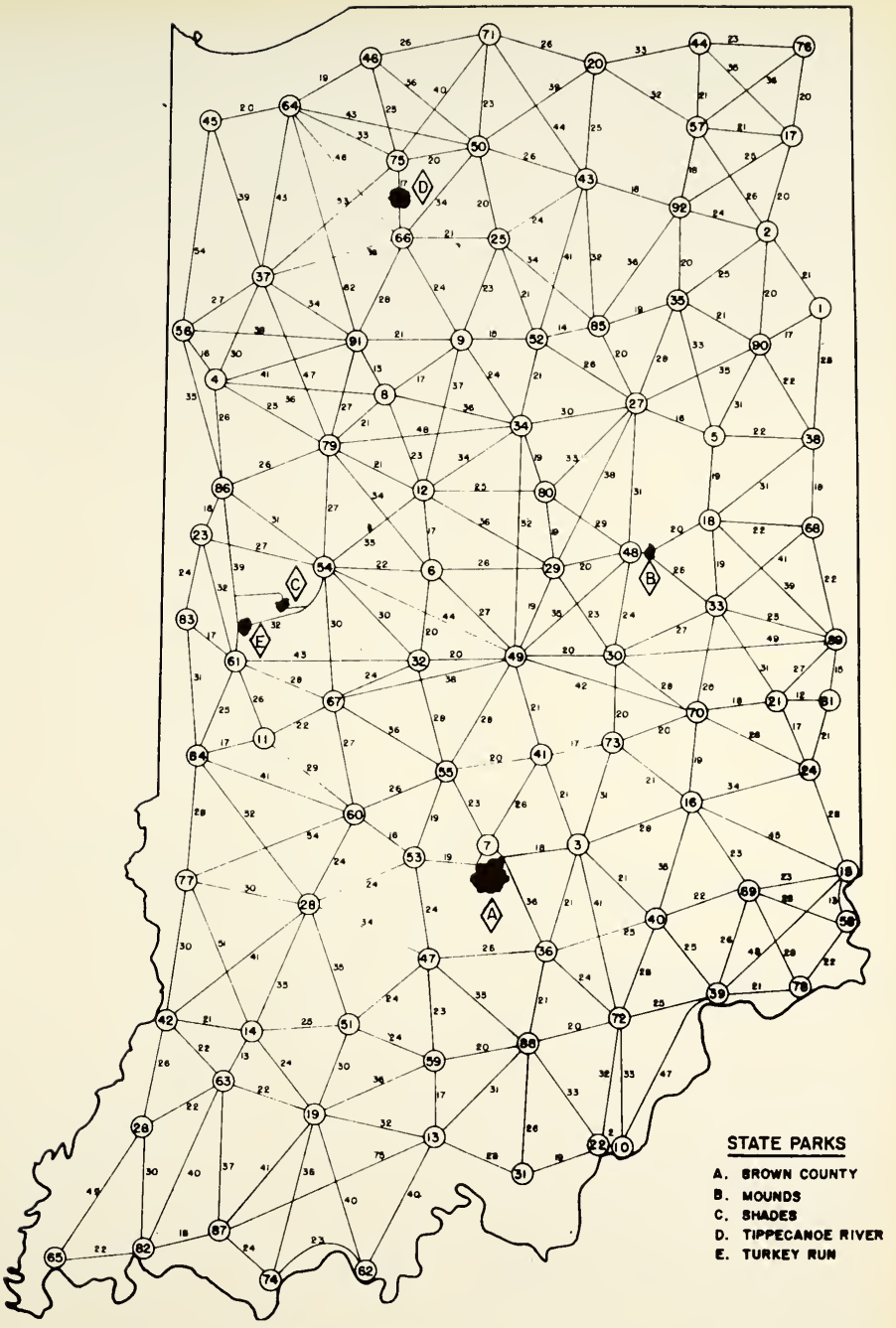
where q^{rj} is an observable

$$K - q^{rj}_{x} = \frac{T^{r} \quad T^{j}}{q^{rj}} \quad x$$

in the form

procedures. The basis property would be preserved

In 1940 In sequence, the



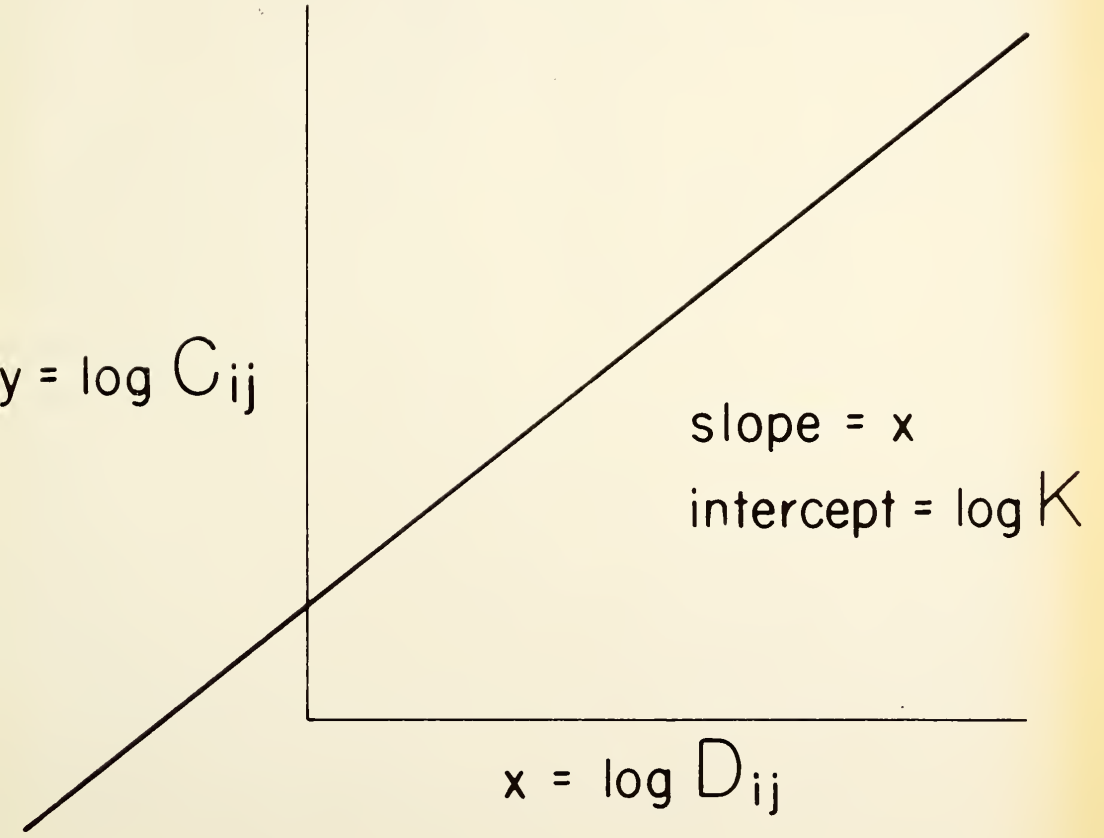
TRAVEL DISTANCE BETWEEN COUNTY SEATS OF INDIANA

Figure 2

x are unknown constants to be determined. For every observation of D_{ij}, there is a corresponding value for C_{ij}. When the log of both sides of the equation is taken, the resultant form is

$$\log C_{ij} = \log K + x \log D_{ij}$$

which is similar to the general equation for a straight line $y = A + BZ$, where y is equal to $\log C_{ij}$; Z is equal to $\log D_{ij}$; the y-intercept is equal to log K; and the slope of the line is equal to x.



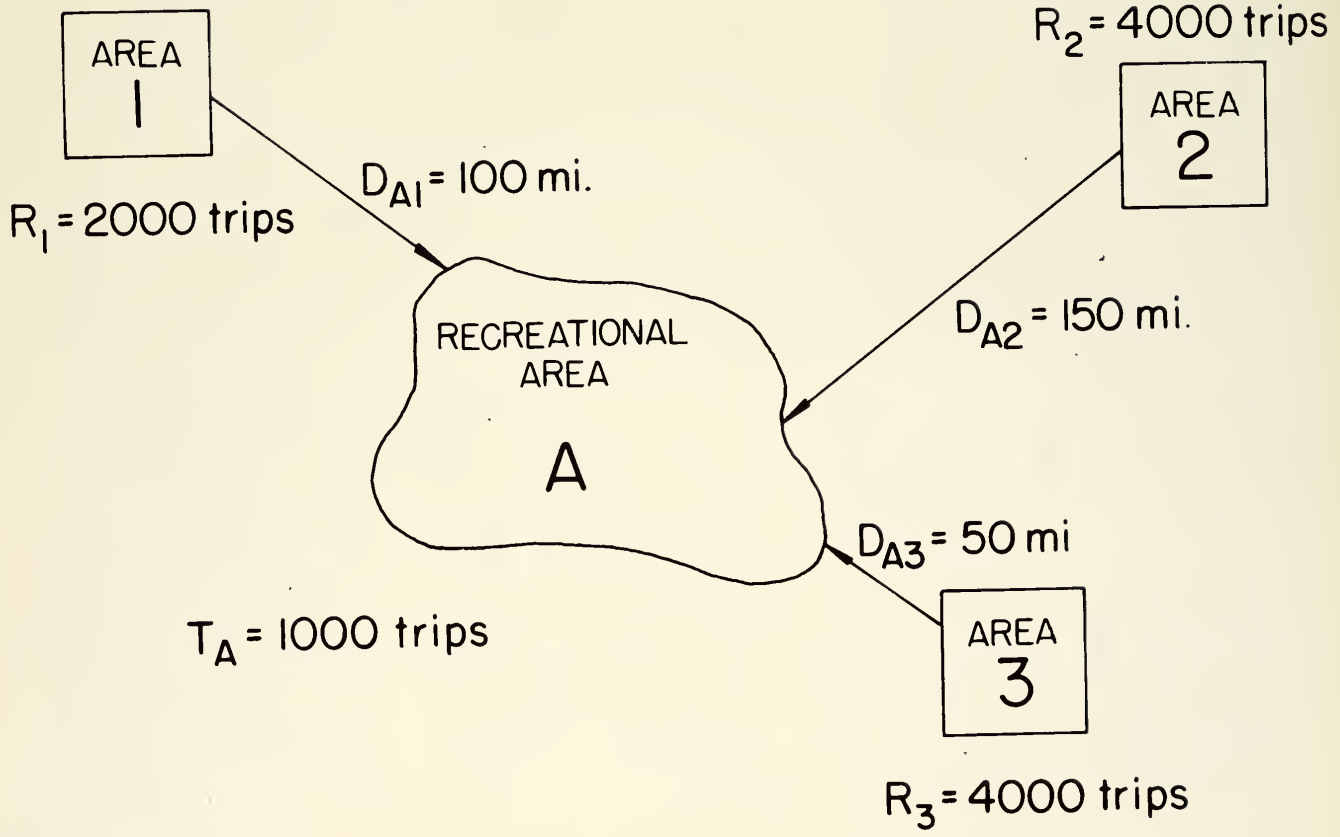
Theoretically, then a plot of the values of log T_{ij} and log D_{ij} should approximate a straight line with the above characteristics and the slope and y-intercept of the theoretical line can be determined by performing a simple linear regression analysis. Returning then to the gravity model, the value x is numerically equal to the slope of the plotted log values and K is equal to the antilog of the y-intercept of the plotted log values.

Based on the previous definitions and calculation procedures the model can be stated in its final computational form as follows:

$$T_{ij} = T_i \frac{\frac{R_j}{D_{ij}^{1.64}}}{\sum_{j=1}^{n} \frac{R_j}{D_{ij}^{1.64}}}$$

Having defined the model let us now use it in the following manner. Assume we have the system shown in Figure 3. We have a proposed Recreational Area A and wish to determine the number of recreational trips which the proposed area will attract from residential areas 1, 2 and 3. We know Area 1 which is 100 miles away can generate a total of 2000 recreational trips, Area 2 which is 150 miles away can generate 4000 trips, Area 3 which is 50 miles away can generate 4000 trips. We also know that the proposed area has the ability of attracting a total of 1000 trips from the surrounding areas. By proper usage of the gravity model we can determine that 122 trips will originate from Area 1, 128 trips will originate from Area 2 and 750 trips will originate from Area 3.

The previous sections have dealt with the determination of the constant terms in the gravity model. As pointed out, these constants were determined on the basis of field observation of the total number



EXAMPLE OF A GRAVITY MODEL DISTRIBUTION

Figure 3

of trips to the park. This procedure was valid for determining the constants, but for prediction purposes this procedure would be impossible since the proposed area would not be in existence at this stage and no observations could be made. Therefore, it was necessary to (1) develop a method of prediction of the total trips that will be attracted to a proposed recreational area, and (2) determine that area over which the trips should be distributed.

For the first, it was decided to evolve a multiple regression model based on the characteristics of the area proposed. This decision was based on the feeling that the total number of trips attracted to a recreational area will be some function of its size, facilities, activities and adjacent populations.

The model was based upon data from the twenty State Parks, Beaches and Recreational Areas in the Indiana State Park System. The variables, forty-eight in number, were obtained from various charts and reports supplied by the Indiana Department of Conservation, Division of State Parks. These variables were compared with the total weekend trips to each of the corresponding parks. The sampling period was a thirteen week span beginning with the weekend of June 2, 1963 and ending with the weekend of August 25, 1963.

Because of the magnitude of a multiple regression analysis using forty-eight variables, the analysis was performed by computer. The format used required that the variables be read into the computer in order of their importance. A first order correlation between the dependent variable and each of the independent variables was determined. On the basis of this correlation the variables were ordered and input into the computer. The analysis resulted in the following ten term equation

of prediction

$$y = -90.36 + 0.61X_1 - 0.03X_2 + 3.60X_3 + 0.22X_4 - 0.65X_5$$
$$-0.26X_6 - 0.73X_7 - 63.08X_8 + 21.77X_9 + 0.11X_{10}$$

where:

y = Total weekend trips to a park

X_1 = Number of picnic tables

X_2 = Number of campsites

X_3 = Area of the lake (in hundreds of acres)

X_4 = Acres of the park extensively developed

X_5 = Availability of a bath house on premises

X_6 = Capacity of total living facilities (in guest nights)

X_7 = Availability of fishing

X_8 = Location on a river

X_9 = Availability of electricity

X_{10} = Population within 60 miles of park (in thousands)

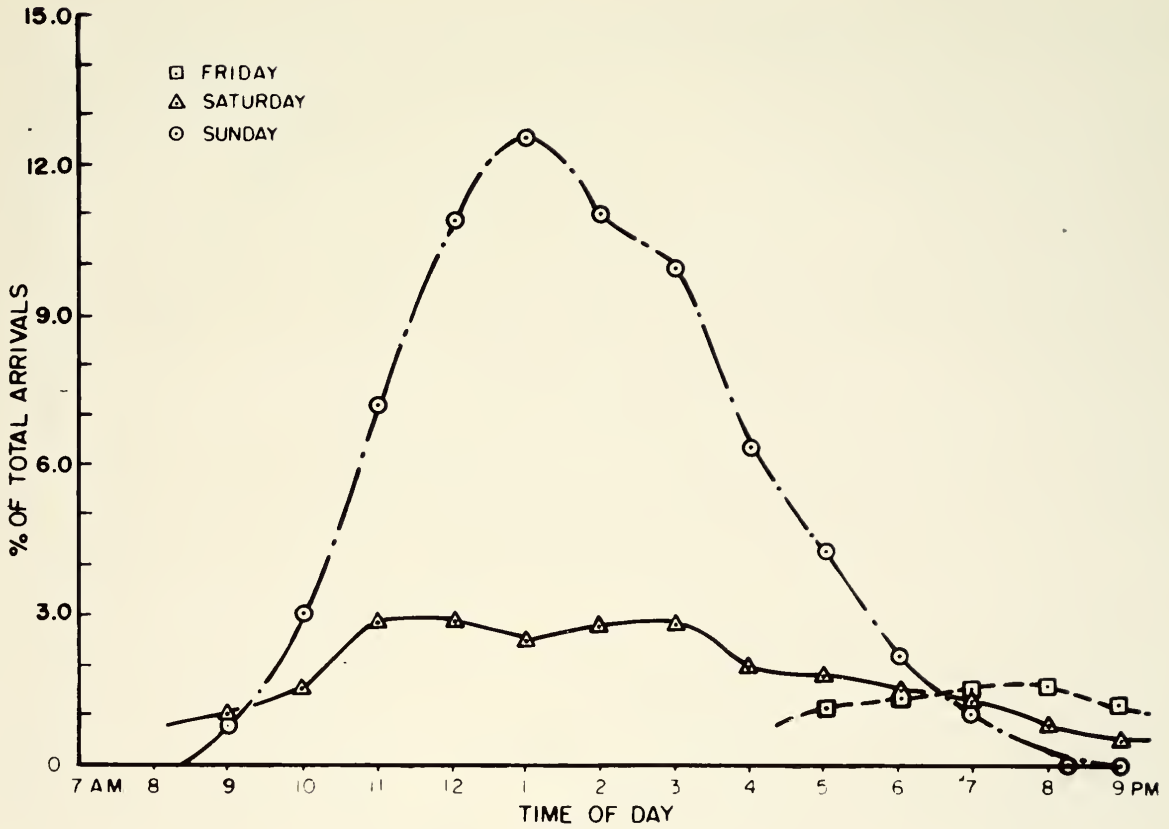
The regression model had a coefficient of correlation (r) of .926 and a standard deviation of 30.9 trips.

Since the function of the gravity model is to distribute the predicted number of attracted recreational trips from the park to their counties of origin, the sphere of influence of the park or the distance from which a recreational facility has the ability to attract trips, must be determined. Having this distance, then the predicted recreational trips can be distributed among all the counties within the specified distance. For this purpose several curves were developed based on the data collected at the five parks during the field study. For each park, all the counties represented were arranged numerically

by increasing distance from the park and the cumulative percentage at each distance determined. Figure 4 shows the relation between the cumulative percentage of total trips and the distance within which these trips occurred.

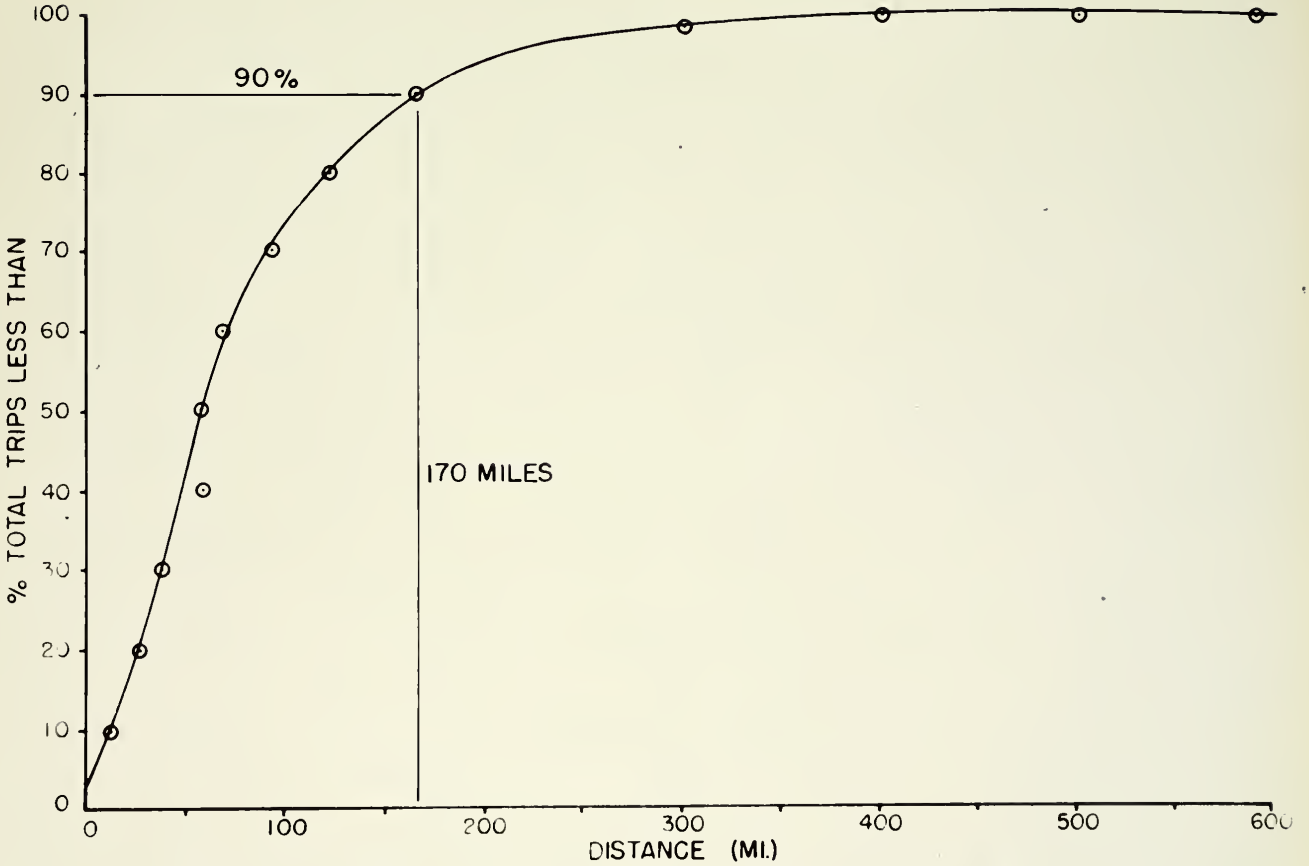
Realizing that a small percentage of arrivals at state parks come from an impulse stop of a through driver, or a visitor on a social trip to a nearby friend or relative, it was deemed sufficient to account for only 90% of the total trips. The curve indicates that on the average 90% of the total trips will occur from within 148 miles of the park and this is the figure recommended for use.

In the way of further analysis of the characteristics of recreational travel, two studies were performed to determine the distribution of arrivals at State Parks. The first study based on all twenty areas indicated that between 65-68% of the total recreational trips are made during a week occur on the weekend. The second study based on the five state parks sampled was made to determine the peak hour of arrival on the weekend. The resultant curve is presented in Figure 5. This study indicates that the peak hour of arrival on Friday evening is between 7:00-8:00 p.m. during which nearly 2% of the total weekend trips arrive and that the peak hour of arrival on Sunday is between noon-1:00 p.m. during which nearly 10% of the total weekend trips arrive. On Saturday there does not seem to be one peak hour, but an almost constant arrival rate between the hours of 10:00 a.m. and 3:00 p.m. with a slight decrease at 1 o'clock. During this period 10% of the total weekend trips arrive. It is also interesting to note the predominance of Sunday arrivals. Nearly 70% of the weekend arrivals occur on Sunday.



PERCENTAGE OF TOTAL ARRIVALS TO ALL STATE PARKS
DISTRIBUTED BY TIME OF DAY

Figure 4



RELATIONSHIP BETWEEN DISTANCE FROM ALL PARKS AND CUMULATIVE PERCENTAGE OF TRIPS

Figure 5